

distinctly claim the subject matter Applicant regards as the invention. The specification has been amended to correct typographic errors. No new matter is added.

Favorable reconsideration of this application in light of the above amendment and the following remarks is respectfully requested.

I. Objection to the Specification

The disclosure is objected to because a TEMPO compound is mistyped as “2,2,6,6-tetramethyl-1-piperidyloxy” in the specification, as stated on page 4, ¶ 2 of the Office Action.

Applicant has corrected the typographic error as suggested by the examiner. Therefore, the objection has been overcome.

II. Claim Rejection under 35 U.S.C. 103 over Veregin et al.

Claims 1-33 are rejected under 35 U.S.C. 103 (a) as allegedly being unpatentable over US 5,610,250 to Veregin et al. (hereafter “Veregin”), as stated on pages 2-3, ¶ 1 of the Office Action.

Claims 5 and 7 have been canceled. Therefore, the rejection of these claims should be withdrawn as moot.

Claim 1 has been amended to particularly point out and distinctly claim the subject matter Applicant regards as the invention.

In determining the differences between the prior art and the claims, the question under 35 U.S.C. 103 is not whether the differences themselves would have been obvious, but whether the claimed invention as a whole would have been

obvious. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 218 USPQ 871 (Fed. Cir. 1983); MPEP § 2141.02. The prior art must teach or suggest all of the claim limitations. MPEP § 2143.

Veregin discloses a polymerization process for a polymer with narrow polydispersity using a large amount of the stable free radical. The process comprises heating a mixture comprised of a free radical initiator, a stable free radical agent, at least one polymerizable monomer compound, and optionally a solvent, to form a polymer with a narrow polydispersity. The polymer is comprised of a covalently bound free radical initiator fragment at one end and a covalently bound non-nitroxide containing stable free radical moiety at the other end of the polymer. (Veregin, col. 8, lines 33-46; claim 1). The molar ratio of the stable free radical (SFR) agent to free radical initiator (INIT) is from 0.5 to 5.0, and preferably in the range from 0.4 to 4.0. Particularly, the molar ratio [SFR:INIT] of stable free radical agent, e.g., 2,4,6-tri-tert-butyl phenoxy radical, to free radical initiator, e.g., benzoyl peroxide is 2.0 and is believed to be important for the success of the process. If the molar ratio [SFR:INIT] is too low then the reaction product has undesired increased polydispersity. (Veregin, col. 24, lines 9-25).

In contrast, the present invention is directed to a polymerization process for manufacturing polymers with narrow polydispersity and block copolymers using a very small amount of stable free radical. As stated in the specification, traditional radical polymerization processes, e.g. the process of Veregin, need to use high concentrations of stable free radical to obtain a polymer with narrow polydispersity. Such a large amount of stable free radical causes economic disadvantage and other problems, e.g., toxicity. In addition, these prior

processes have very slow kinetics and cannot polymerize or copolymerize certain monomers such as methacrylates. (specification, page 1, lines 9-20). Accordingly, the present invention solves the above problems by using a very small amount of stable free radical, while at the same time producing polymers with narrow polydispersities or producing block copolymers. (specification, page 1, lines 20-27).

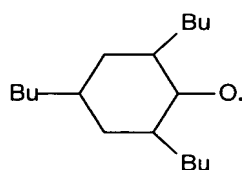
The process as recited in the amended claim 1 comprises a step of polymerization or copolymerization of at least one monomer via a radical route in the presence of an initiator and of a stable free radical under the conditions that, per 100 mol of monomer, $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})] < 0.15$; $F_{\text{SFR}} \times (\text{SFR})$ ranging from 0.0001 to 0.2 mol; and $F_{\text{INIT}} \times (\text{INIT})$ ranging from 0.01 to 20 mol. Here, (SFR) and (INIT) represent the number of moles of stable free radical and of initiator, respectively. F_{SFR} and F_{INIT} represent the functionality of the stable free radical and of the initiator, respectively. (page 1, lines 20-25).

Veregin discloses a polymerization process to produce polymers with narrow polydispersity of 1.0-2.0 using high concentrations of stable free radical with the preferred molar ratio [SFR:INIT] of 0.4-4.0 in general, and the stoichiometric ratio of 2.0 in particular. However, Veregin does not teach or even suggest a polymerization process via a radical route using a very small amount of the stable free radical such that $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})] < 0.15$; $F_{\text{SFR}} \times (\text{SFR})$ ranging from 0.0001 to 0.2 mol; and $F_{\text{INIT}} \times (\text{INIT})$ ranging from 0.01 to 20 mol.

It is readily understood by person of ordinary skill in the art that a large number of conventional stable free radicals (SFR) are monofunctional, i.e., one stable free radical has only one unpaired electron and may be written as SFR^{\bullet} . Thus, the functionality F_{SFR} of the monofunctional stable free radicals is 1. On the

other hand, a large number of the conventional initiators are at least bifunctional, i.e., one initiator compound may break into at least two (2) radicals although one free radical itself is monofunctional and may be written as I^{\bullet} . Therefore, the functionality F_{INIT} of bifunctional initiators is 2.

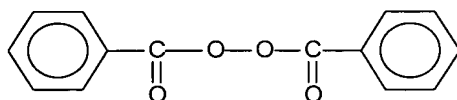
Veregin uses a stable free radical agent (SFR $^{\bullet}$) or equivalent precursor compound (SFR-H). (Col. 13, lines 40-42). SFR $^{\bullet}$ is clearly a monofunctional stable free radical. The precursor compound (SFR-H) contains only one SFR-H bond, thus, the resulted stable free radical--(SFR $^{\bullet}$) is necessarily monofunctional. The exemplified stable free radical used by Veregin, 2,4,6-tri-tert-butylphenoxy radical, is a monofunctional stable free radical, as shown by its formula:



Veregin teaches that the polymerization process produces a product of the formula $I--(M)_n--SFR$ comprised of a covalently bound free radical initiator fragment (I^{\bullet}) at one end, and a covalently bound stable free radical (SFR $^{\bullet}$) at the other end of the product. (col. 13, lines 43-46). The product $I--(M)_n--SFR$ has only two ends, each with one monofunctional species. It is thus clear that Veregin teaches a polymerization process using high concentrations of monofunctional stable free radicals.

Moreover, Veregin uses a free radical initiator (I-I) in the process. (col. 13, lines 40-45). The initiator decomposes into two free radicals I^{\bullet} . In case of the peroxide initiators, a O-O bond breaks to give two $-O^{\bullet}$. The specific initiator

indicated by Veregin, benzoylperoxide, is clearly a bifunctional initiator as shown by the following formula:



It is thus clear that Veregin teaches a polymerization process using bifunctional free radical initiators.

As stated above, Veregin discloses that the preferred molar ratio [SFR:INIT] is 0.4-4.0 in general. Since Veregin uses monofunctional stable free radical and bifunctional initiator, the functionality of the stable free radical F_{SFR} is 1 and the functionality of the initiator F_{INIT} is 2. Thus, $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ in Veregin is 0.2-2.0. As demonstrated by examples in Veregin, all of $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ are higher than 0.26 to obtain the desired narrow polydispersity of 1.0-2.0. Besides, all of $F_{\text{SFR}} \times (\text{SFR})$ are higher than 0.30. Furthermore, Veregin also shows that the stoichiometric [SFR:INIT] of 2, which is equivalent to $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ of 1, is important for the success of the process. For example, when $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ is 0.75, e.g., in Reaction A of Example VI, the peak molecular weights increase with the time, indicating the undesired broad polydispersity. On the other hand, in Reaction B of Example VI as well in Example VII, when the $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ is 1.0, the peak molecular weights remain essentially constant as desired. Furthermore, all of $F_{\text{SFR}} \times (\text{SFR})$ in Veregin are higher than 0.30. These data are collected in the following Table 1 for the Examiner's convenience.

Table 1 $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ and Polydispersity (PD) in Veregin

Ex. No.	$F_{\text{SFR}} \times (\text{SFR})$	$F_{\text{INIT}} \times (\text{INIT})$	$[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$	PD
I	0.92	3.494	0.263	--
II	0.92	1.75	0.53	1.46
III	0.31	0.58	0.53	1.73
IV	0.64	0.87	0.735	1.72
V			1.08	2.39
VI(A)			0.75	undesirably increased
VI(B)			1.0	remain constant
VII			1.0	1.58

Therefore, it is readily understood by person of ordinary skill in the art, following the teachings of Veregin, that $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ should not be lower than 0.2 and $F_{\text{SFR}} \times (\text{SFR})$ should not be lower than 0.31, as demonstrated by the examples and also by the teaching that if the molar ratio [SFR:INIT] is too low then the reaction product has undesired increased polydispersity. (Veregin, col. 24, lines 9-25).

In contrast, in the claimed process, $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ is less than 0.15--much less than those in Veregin and $F_{\text{SFR}} \times (\text{SFR})$ ranges from 0.0001 to 0.2 mol--also much less than those in Veregin. As shown in the examples of the present invention, the $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ in examples 1, 3 and 6 are less than 0.15 and the products have narrow polydispersity. As a comparison,

when $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ is 0.5--higher than 0.15, there is no desired reaction occurred. In addition, Example 4 shows that a block copolymer can also be obtained under the claimed conditions, i.e., $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ is lower than 0.15 and $F_{\text{SFR}} \times (\text{SFR})$ is less than 0.2 mol. These data are collected in the following Table 2 for Examiner's convenience.

Table 2 $F_{\text{SFR}} \times (\text{SFR}) / F_{\text{INIT}} \times (\text{INIT})$ and Polydispersity (I_p) in the Present Invention

Ex. No.	$F_{\text{SFR}} \times (\text{SFR})$	$F_{\text{INIT}} \times (\text{INIT})$	$F_{\text{SFR}} \times (\text{SFR}) / F_{\text{INIT}} \times (\text{INIT})$	I_p
1	0.039	0.4	0.099	1.8
3	0.082	0.83	0.098	1.8
4	0.041	0.415	0.098	2.7
6	0.041	0.415	0.098	1.9
7 (com. ex.)	0.838	1.68	0.50	no methacrylate sequence

As is clearly shown by the contrasting data demonstrated in Table 1 and 2, all of $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ in Veregin are higher than 0.20 and all of $F_{\text{SFR}} \times (\text{SFR})$ are higher than 0.30 to obtain narrow polydispersity. In contrast, in the present invention, all of $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ are less than 0.15 and all of $F_{\text{SFR}} \times (\text{SFR})$ are lower than 0.20 mol, while narrow polydispersities are still obtained and the block copolymers can be manufactured, too. Thus, the claimed invention is directed to a different process from Veregin because they cover different scope.

Therefore, the claimed process, as a whole, is patentably distinct from that of Veregin and Veregin does not teach or even suggest the claimed process.

Applicant respectfully disagrees with the statement on page 3 of the office action that “it would have been obvious to one of ordinary skill in the art to use a process for radical polymerization ... in Veregin’s invention in the presence of a stable free radical and a radical initiator wherein the relationship of (SFR): (INIT)< 0.15 can be obtained in the same ratio since the conditions of the polymerization are under control and the functionality of a stable free radical and a radical initiator can be selected within the same resulting expectation. The motivation is that it is within the skill of one in the art to select a stable radical compound and radical initiator in Veregin’s invention for forming a polymer by radical polymerization wherein the relationship of (SFR): (INIT)< 0.15 can be obtained since the reference discloses that this ratio is depending on the selected stable free radical compound and a radical initiator.”

A prior art reference must be considered in its entirety, i.e., as a whole, including portions that would lead away from the claimed invention. *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984), MPEP 2141.02, p. 2100-109.

Applicants submits that Veregin, in fact, teaches away from the claimed low ranges of $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ and $F_{\text{SFR}} \times (\text{SFR})$. As discussed above, Veregin teaches in general that [SFR : INIT] is preferably from 0.4 to 4.0, which is equivalent to $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ of 0.2-2.0. Then, Veregin emphasizes that stoichiometric [SFR : INIT] of 2.0, which is equivalent to $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ of 1.0, is believed to be important for the success of the process. If [SFR :

[INIT], or $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$, is too low then the reaction product has undesired increased polydispersity. (Veregin, col. 24, lines 9-25). Veregin especially demonstrates by examples that $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ of 1.0 is very important to the process. For example, in Reaction A of Example VI, when the ratio is 0.75, which is, even though, still within the general range of 0.2-2.0, the peak molecular weights increased with increasing time, indicating a constant undesirable increase of the polydispersity. However, in Reaction B of Example VI and also in Example VII, when the ratio is 1.0, the peak molecular weights remain the same with increasing time. Thus, person of ordinary skill in the art would readily understand from the teachings of Veregin that low $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ would lead to polymers with broad polydispersity.

Teaching away is "strong evidence of nonobviousness." *In re Hedges*, 783 F.2d 1038, 1041, 228 USPQ 685, 687 (Fed. Cir. 1986).

Veregin, in teaching away from the use of low [SFR : INIT], which is equivalent to the use of low $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ as addressed above, for the production of the narrow polydispersity polymers as well as the block copolymers, does not and cannot even suggest Applicant's claimed invention. Also, it would not have been obvious for person of ordinary skill in the art, following the teachings of Veregin, to vary the [SFR : INIT] toward the opposite direction by selecting a stable free radical and a free radical initiator so that [SFR : INIT] would be less than 0.4, which is equivalent to the $[F_{\text{SFR}} \times (\text{SFR})] / [F_{\text{INIT}} \times (\text{INIT})]$ of less than 0.2 as addressed above. Therefore, there is no motivation and/or expectation of success as alleged in the Office Action and the claimed process is patentably distinct from Veregin.

Claims 2-4, 6, and 8-33, each dependent from claim 1, are also not obvious, *inter alia*, for all of the reasons delineated above, because each of these dependent claims is directed to a combination including everything recited in the corresponding independent claim 1.

Accordingly, Applicant submits that rejection of the claims 1-33 under 35 U.S.C. 103 (a) has been overcome and request that it be withdrawn.

III. Conclusion

In view of the above amendment and remarks, Applicant submits that all of rejections and objection in the Office Action have been overcome and all claims are now in condition for allowance, early and favorable notice of which would be appreciated.

In the event that all of the claims are not allowed, Applicant specifically requests a personal or telephonic interview to discuss any remaining issues and thereby accelerate the eventual allowance of all of the present claims.

A separate Supplemental Information Disclosure Statement is filed concurrently. No fee, other than that for Supplemental IDS, is believed to be due for this submission. Should any fee be required in connection with or as an adjunct to this submission, please charge it to Deposit Account No. 16-1150.

Respectfully submitted,

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